Fig.1.

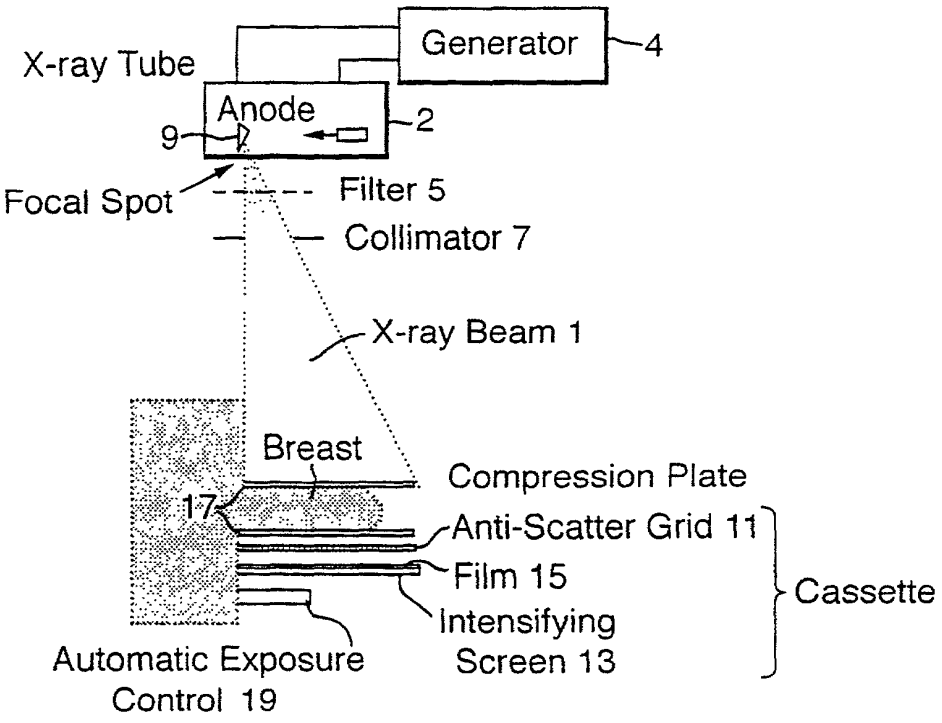

X-ray Tube
Generator
4
Anode
2
9
Focal Spot
Filter 5
Collimator 7
X-ray Beam 1
Breast
Compression Plate
17
Anti-Scatter Grid 11
Film 15
Intensifying
Screen 13
Cassette
Automatic Exposure
Control 19

Fig.2.

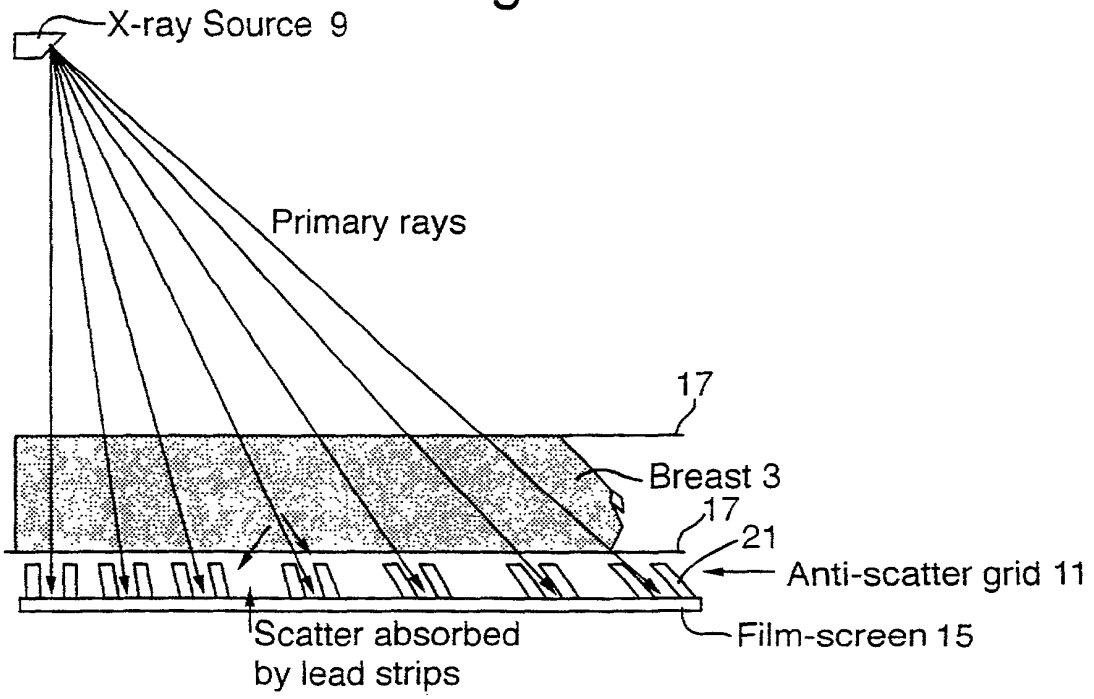

X-ray Source 9
Primary rays
17
Breast 3
17
21
Anti-scatter grid 11
Scatter absorbed
by lead strips
Film-screen 15

Fig.3.

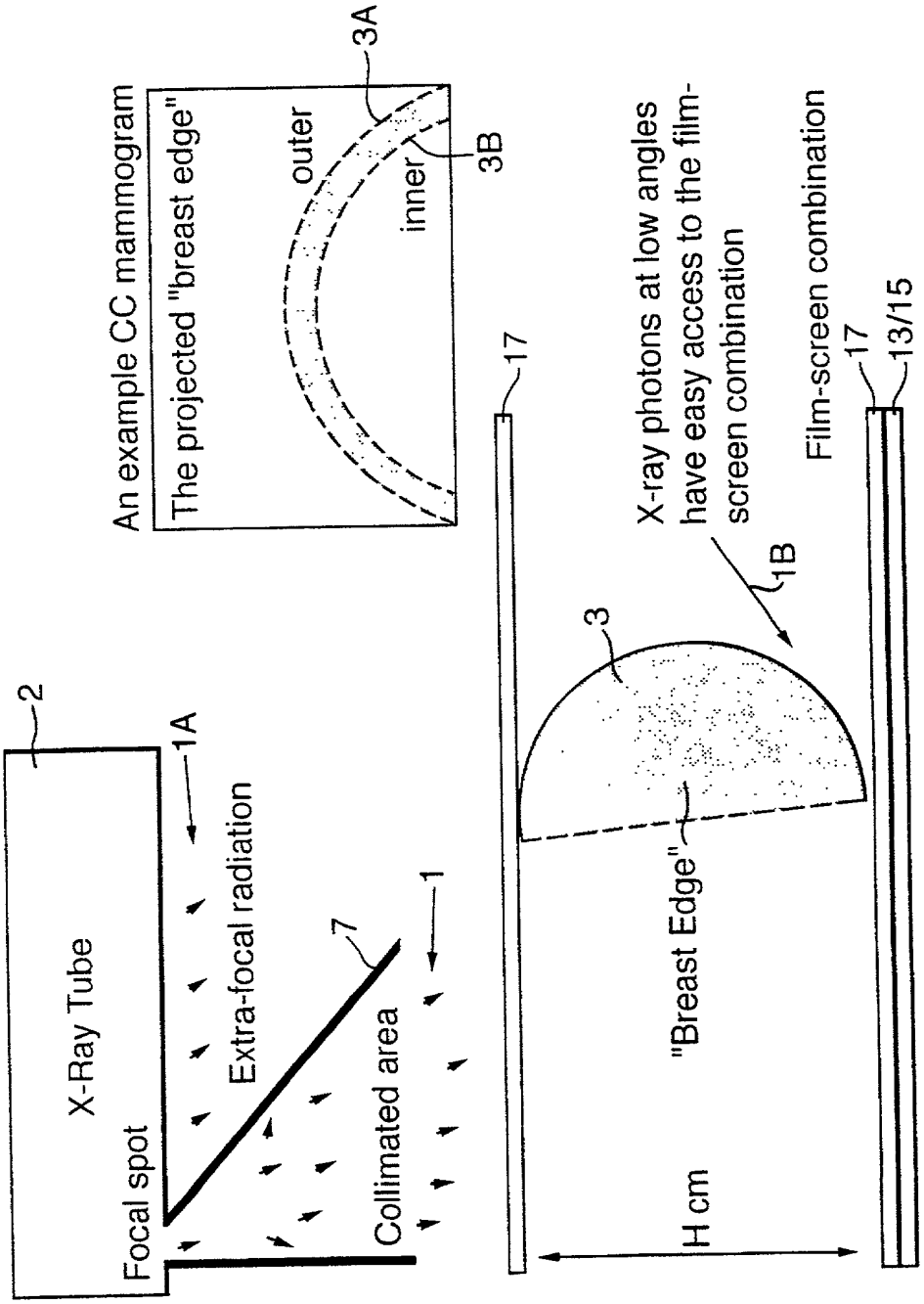

An example CC mammogram
The projected "breast edge"
outer
inner
3A
3B
2
1A
X-Ray Tube
Focal spot
Extra-focal radiation
7
1
Collimated area
17
3
X-ray photons at low angles have easy access to the film-screen combination
1B
"Breast Edge"
H cm
Film-screen combination
17
13/15

Fig.4.

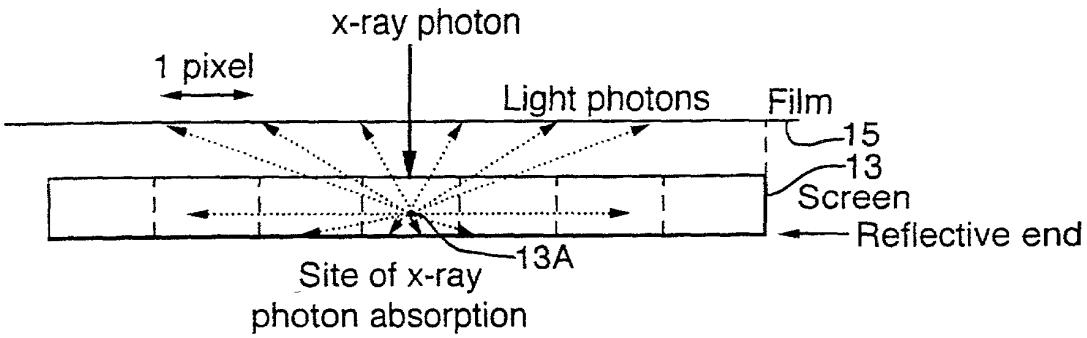

x-ray photon
1 pixel
Light photons
Film
15
13
Screen
Reflective end
13A
Site of x-ray
photon absorption

Fig.5.

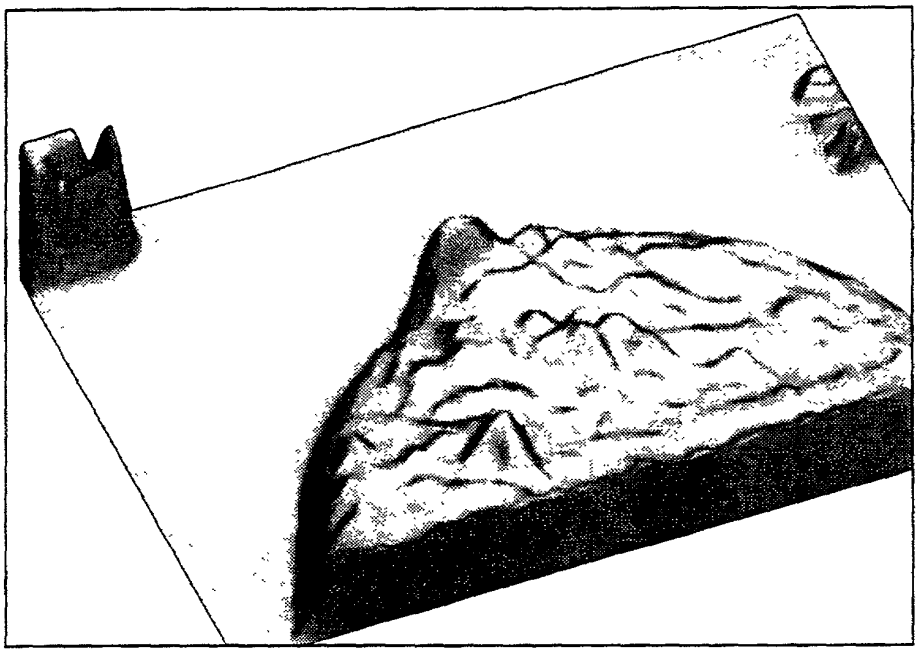


Fig.6.

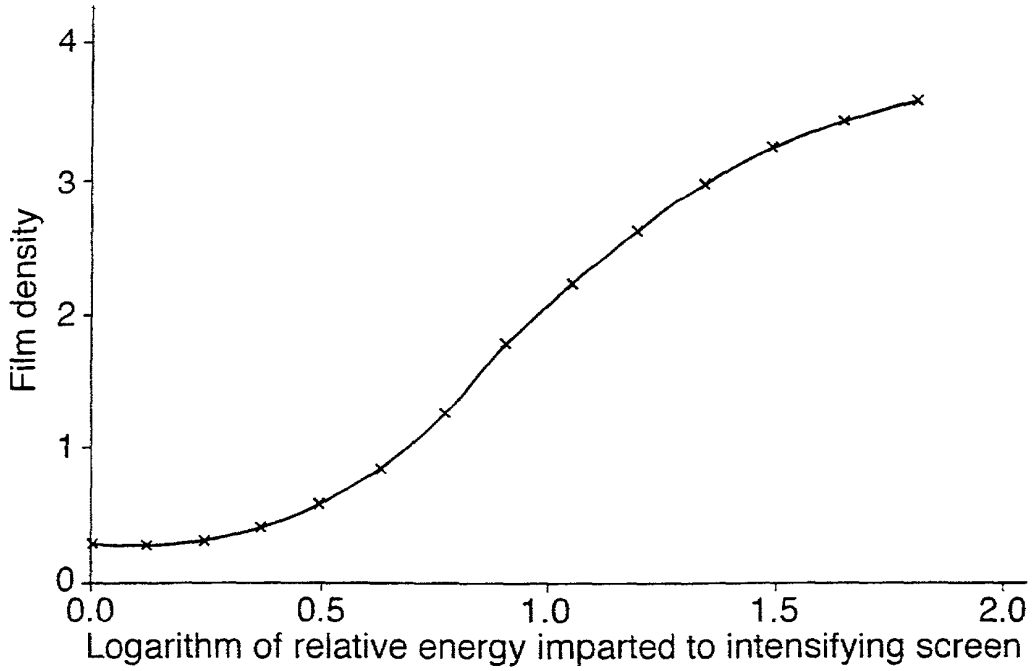
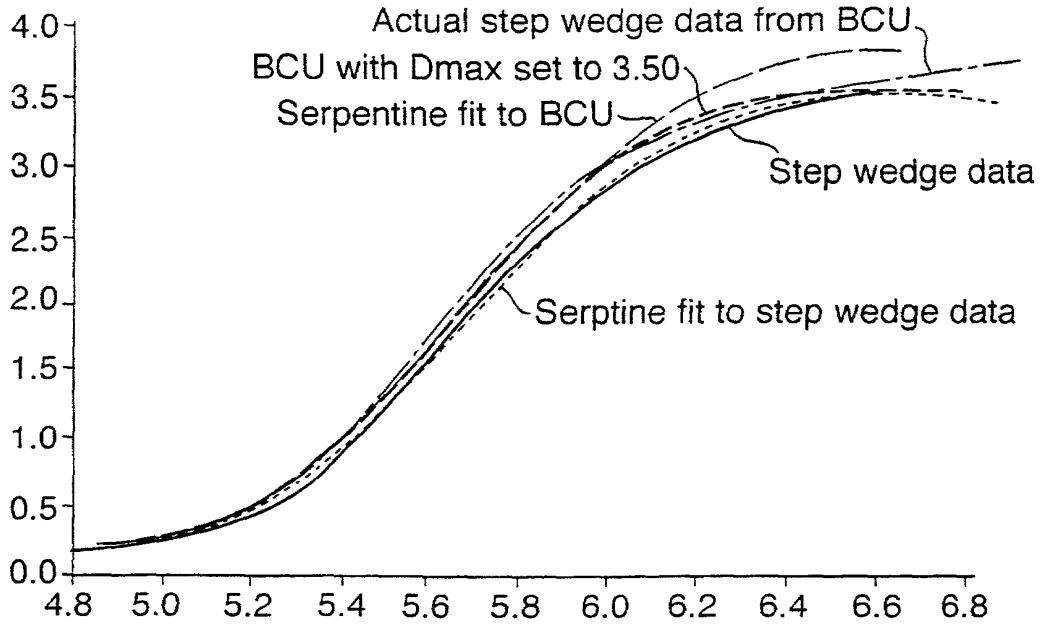

Film density
0
1
2
3
4
0.0
0.5
1.0
1.5
2.0
Logarithm of relative energy imparted to intensifying screen

Fig.7.


Actual step wedge data from BCU
BCU with Dmax set to 3.50
Serpentine fit to BCU
Step wedge data
Serptine fit to step wedge data
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8

5/17

Fig.8.

Example of glare removal

Original Energy Image

Glare-Removed Energy Image

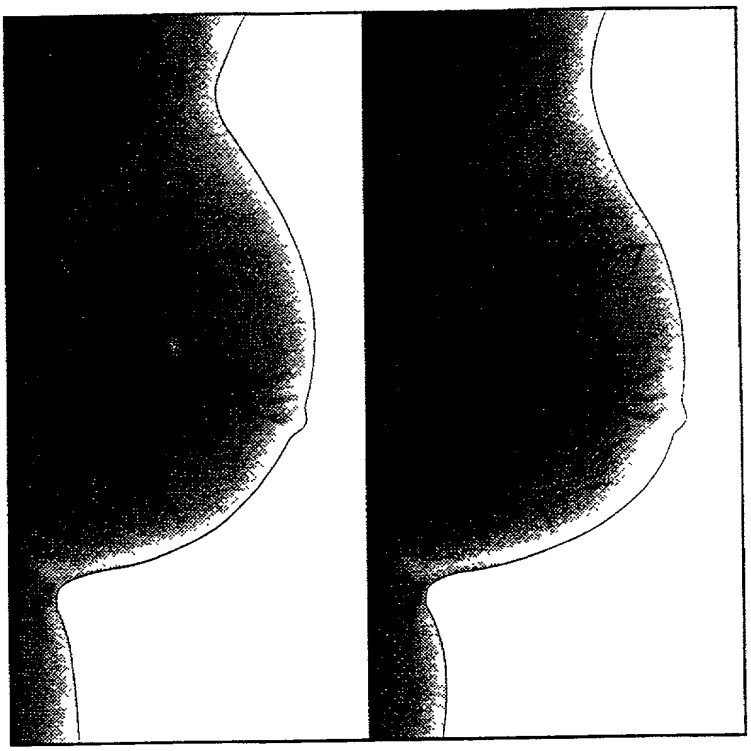


Fig.9.

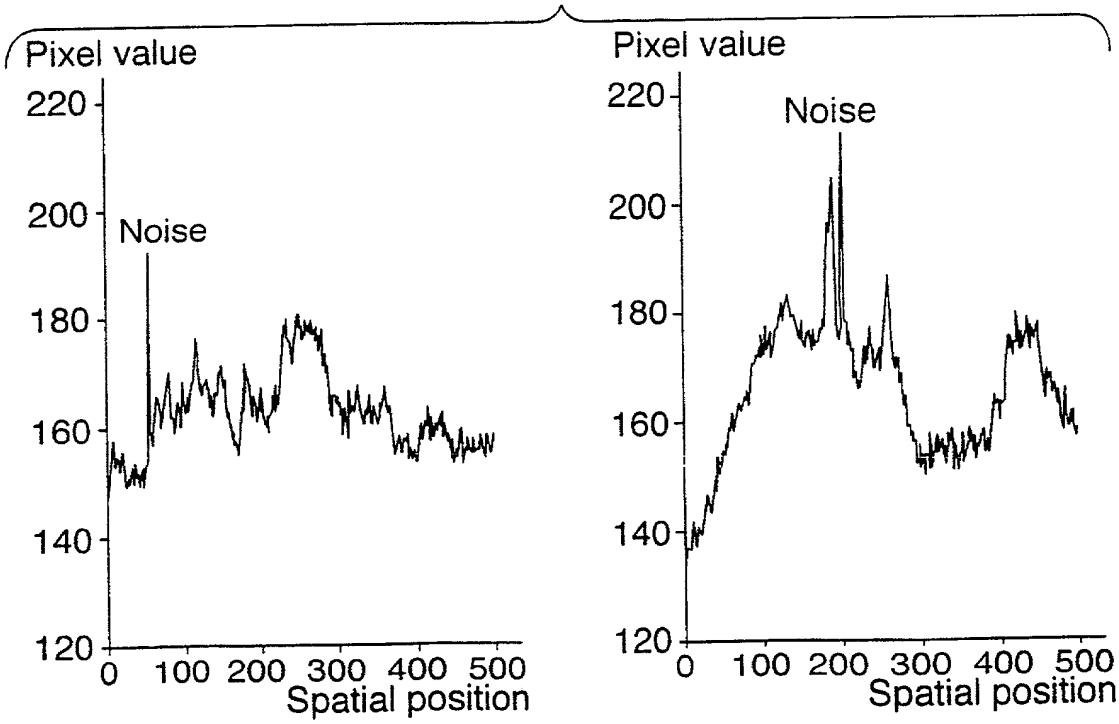


Fig.10.

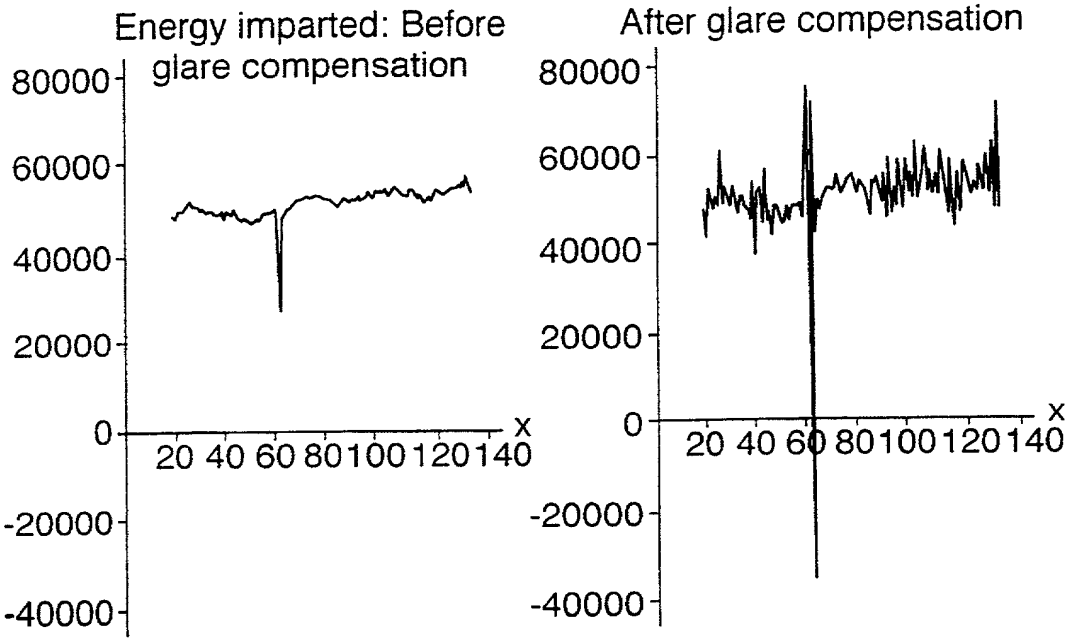

Energy imparted: Before glare compensation
80000
60000
40000
20000
0
-20000
-40000
X
20 40 60 80 100 120 140
After glare compensation
80000
60000
40000
20000
0
-20000
-40000
X
20 40 60 80 100 120 140

Fig.11.

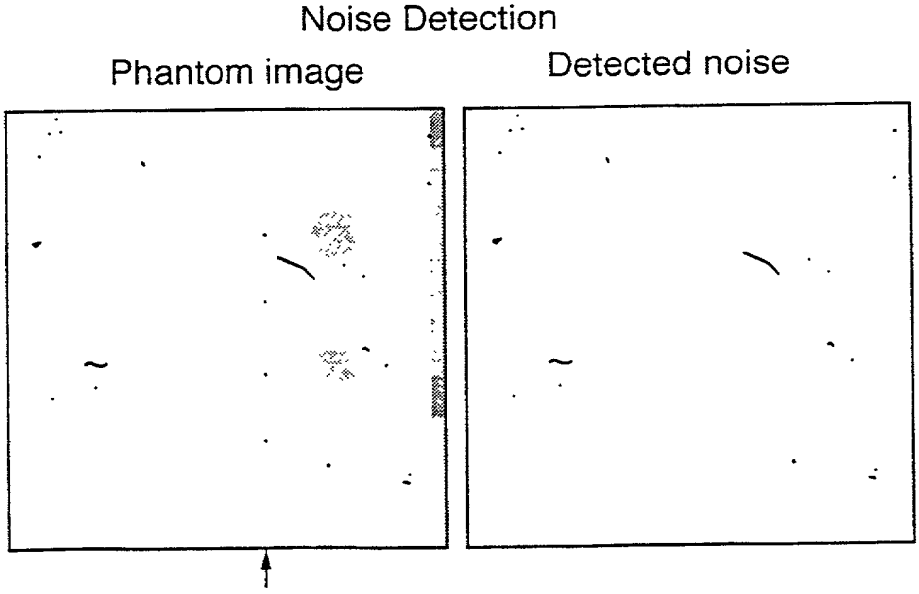

Noise Detection
Phantom image
Detected noise

Fig.12.

Noise Detection : Real Image

Real image Detected noise

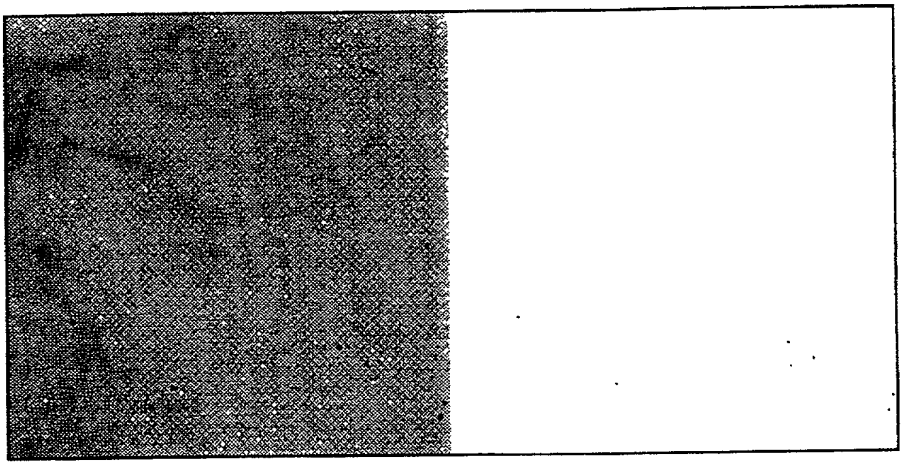


Fig.13.

Noise Detection : Real Image

Real image Detected noise

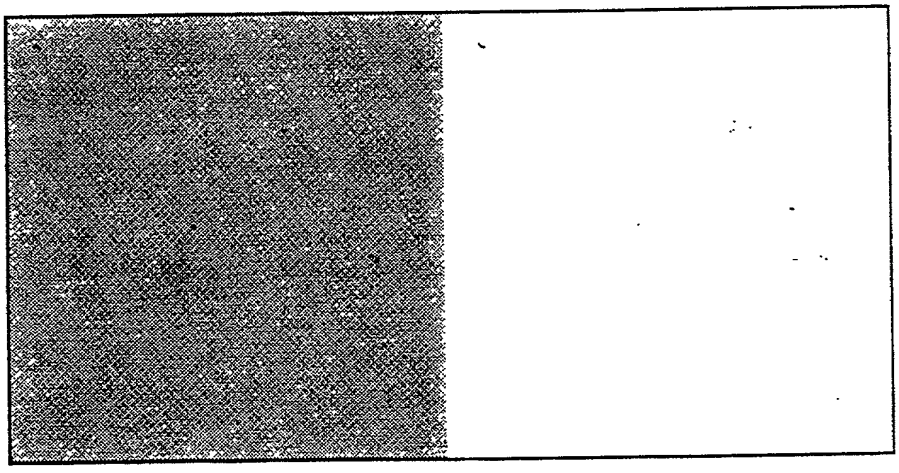
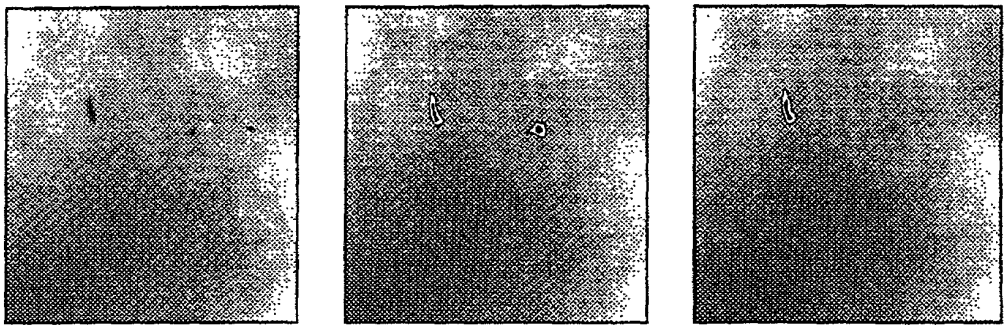


Fig.14.

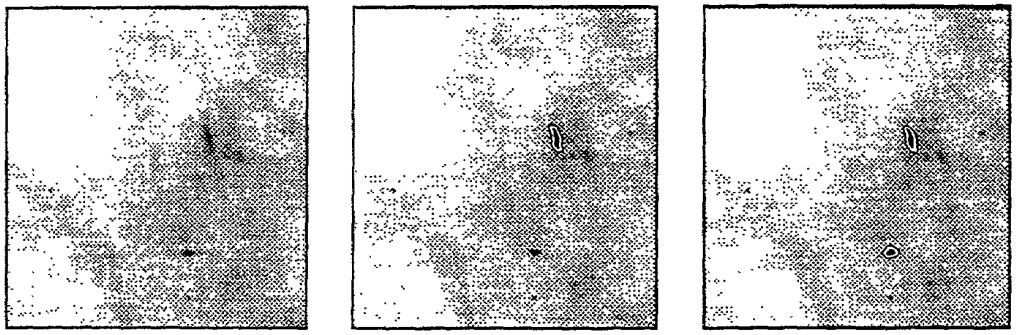
Detecting low-contrast microcalcifications



(a) (b) (c)

Fig.15.

Detection of false positives



(a) (b) (c)

Fig.16.

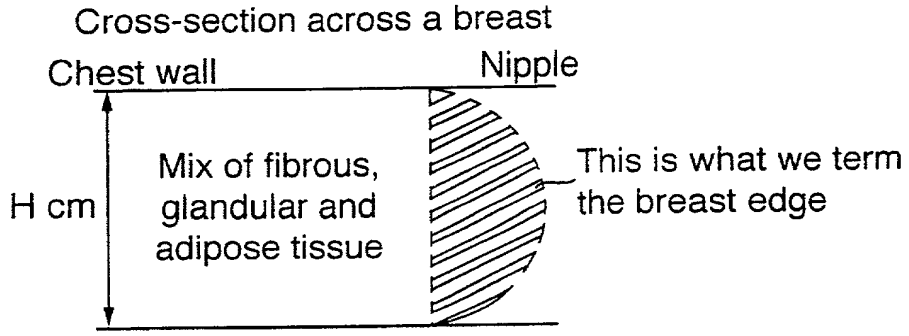

Cross-section across a breast
Chest wall
Nipple
H cm
Mix of fibrous, glandular and adipose tissue
This is what we term the breast edge

Fig.17.

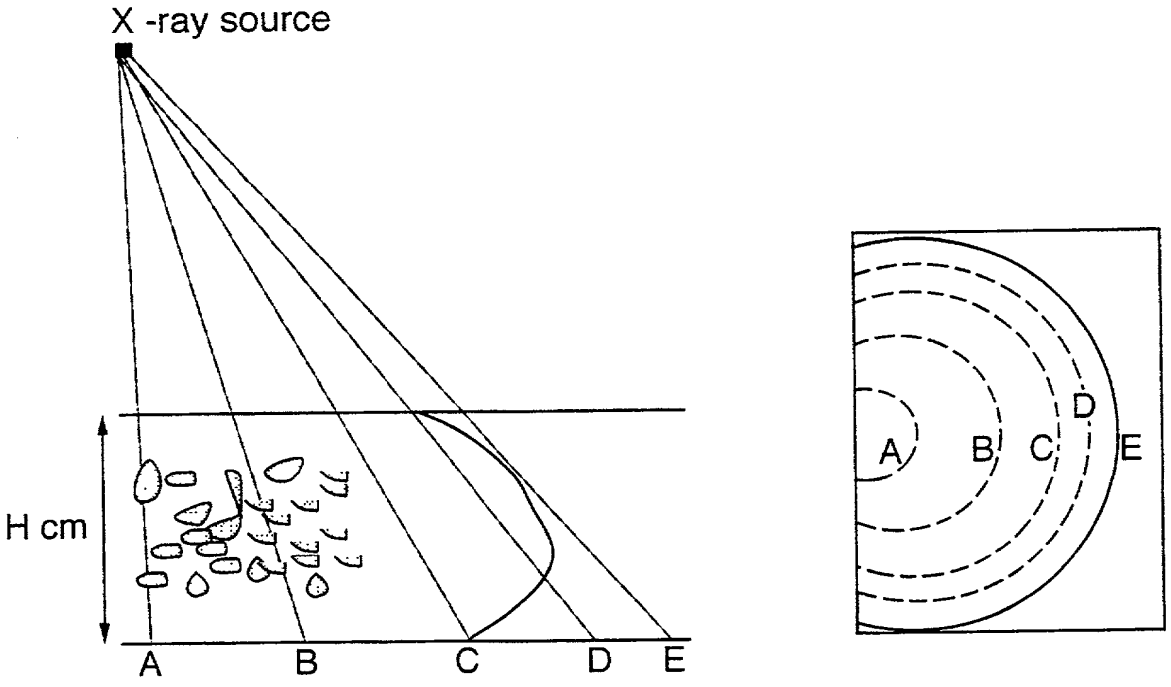

X -ray source
H cm
A
B
C
D
E
A
B
C
D
E

Fig.18.

Examples of the projected breast edge

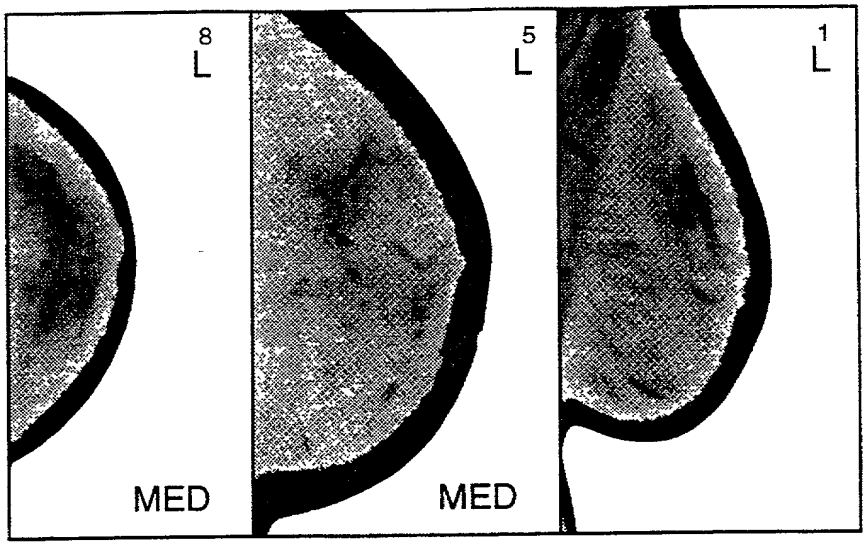


Fig.19.

Change in the breast edge with *H*

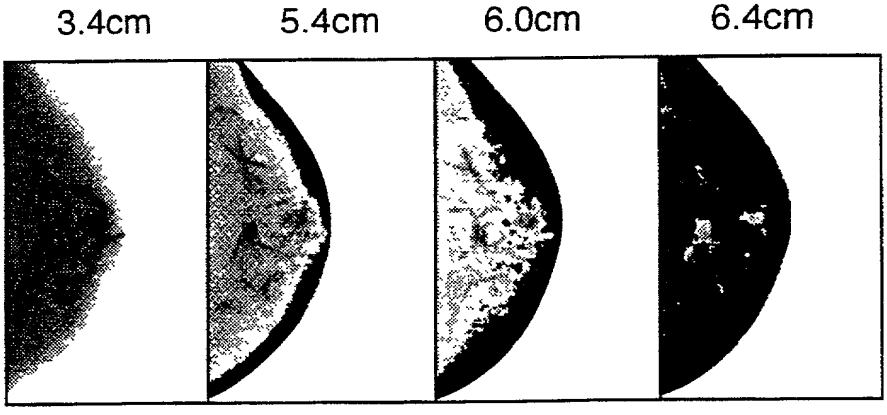


Fig.20.

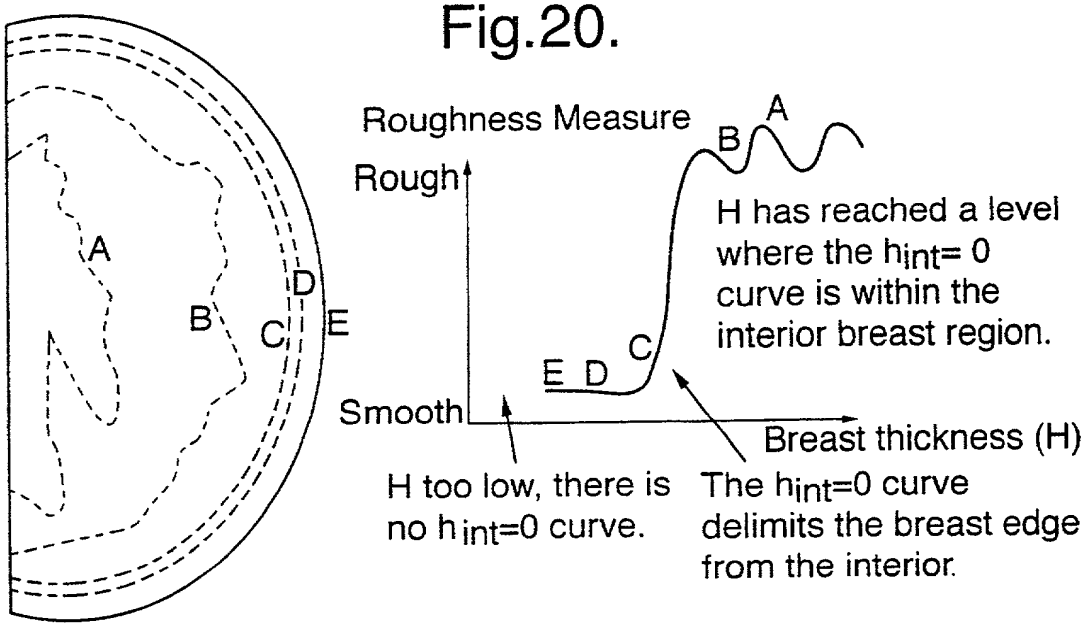


Fig.21.

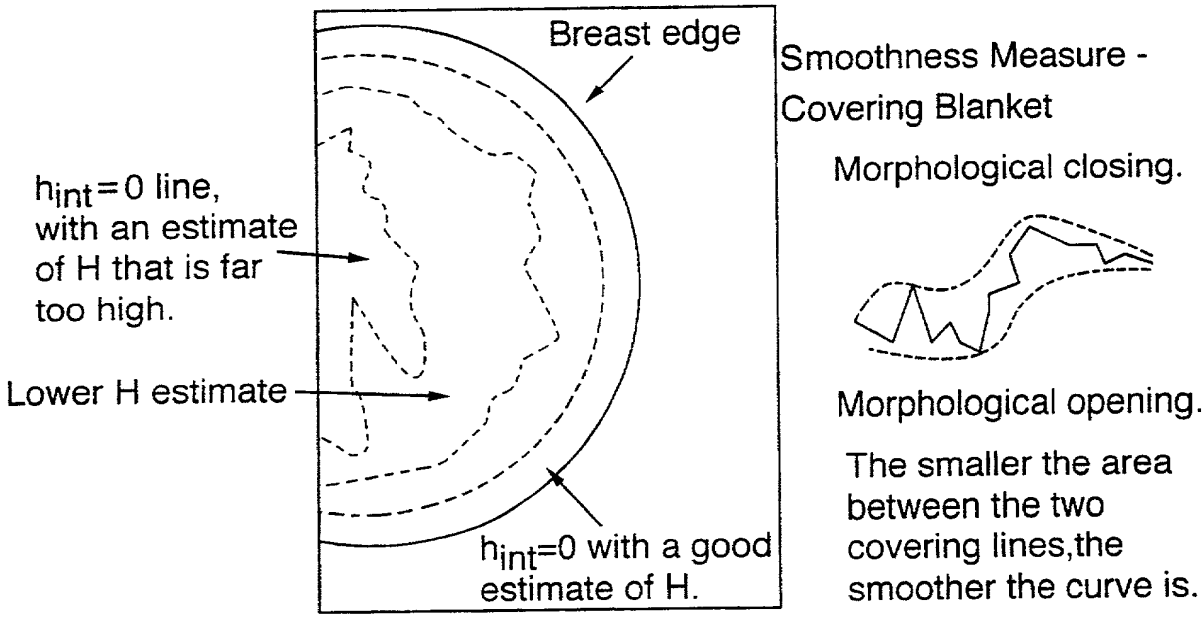


Fig.22.

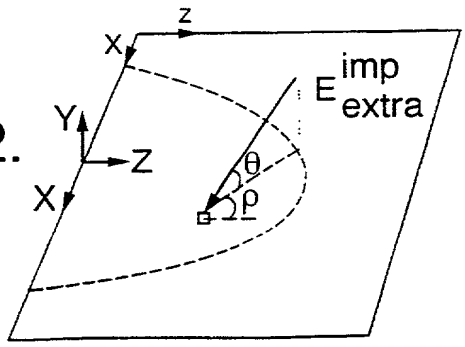


Fig.23.

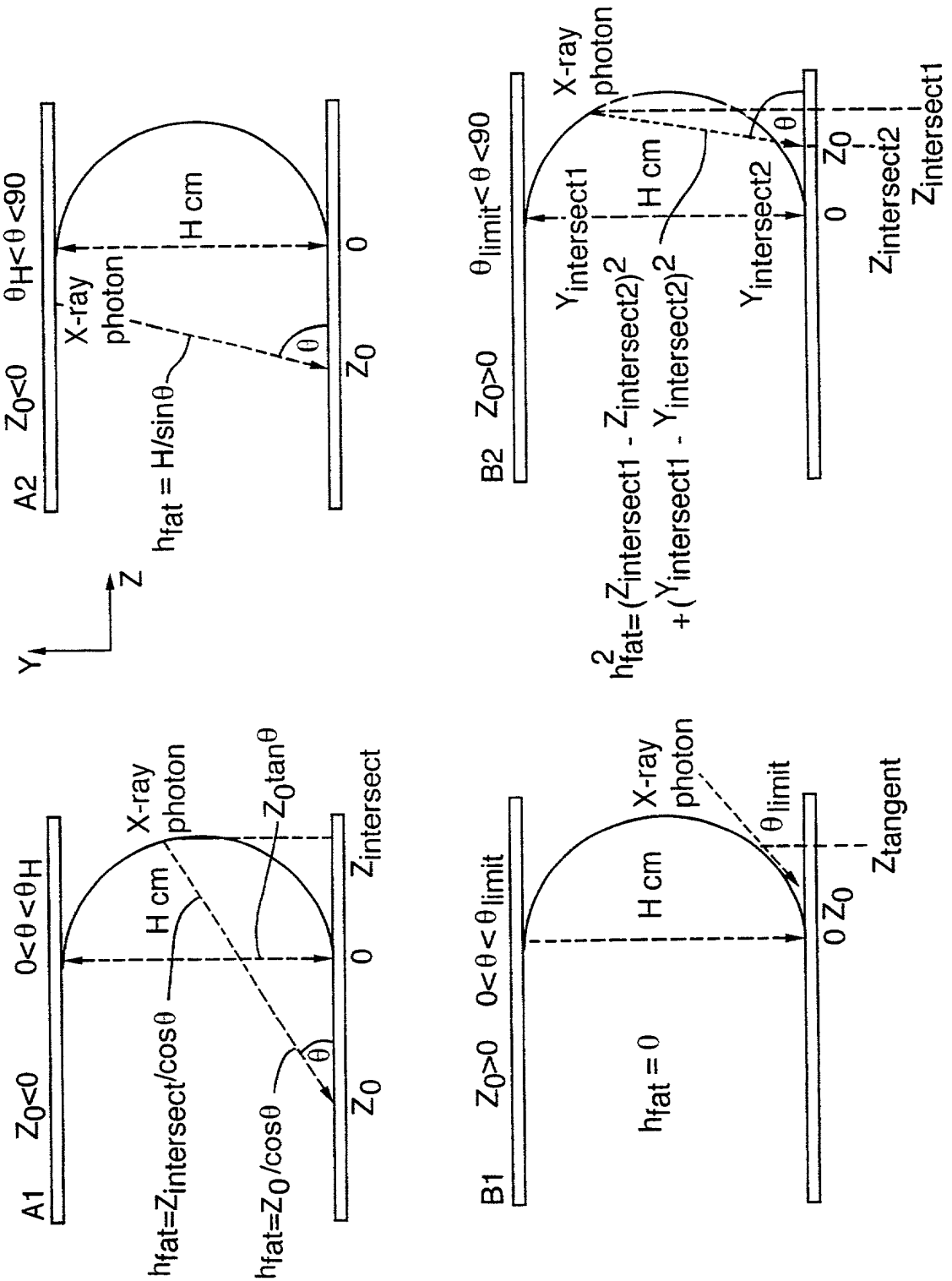

A2
$Z_0<0$
$\theta_H<\theta<90$
X-ray photon
H cm
0
Z_0
$h_{fat} = H/\sin\theta$
θ
Y
Z
B2
$Z_0>0$
$\theta_{limit}<\theta<90$
X-ray photon
$Y_{intersect1}$
H cm
$Y_{intersect2}$
0
Z_0
$Z_{intersect2}$
$Z_{intersect1}$
$h^2_{fat} = (Z_{intersect1} - Z_{intersect2})^2 + (Y_{intersect1} - Y_{intersect2})^2$
A1
$Z_0<0$
$0<\theta<\theta_H$
X-ray photon
H cm
$Z_0\tan\theta$
$Z_{intersect}$
0
Z_0
$h_{fat}=Z_{intersect}/\cos\theta$
$h_{fat}=Z_0/\cos\theta$
B1
$Z_0>0$
$0<\theta<\theta_{limit}$
X-ray photon
H cm
θ_{limit}
$Z_{tangent}$
0
Z_0
$h_{fat} = 0$

Fig.24.

Examples of extra-focal radiation

Original image Energy imparted Extra-focal component

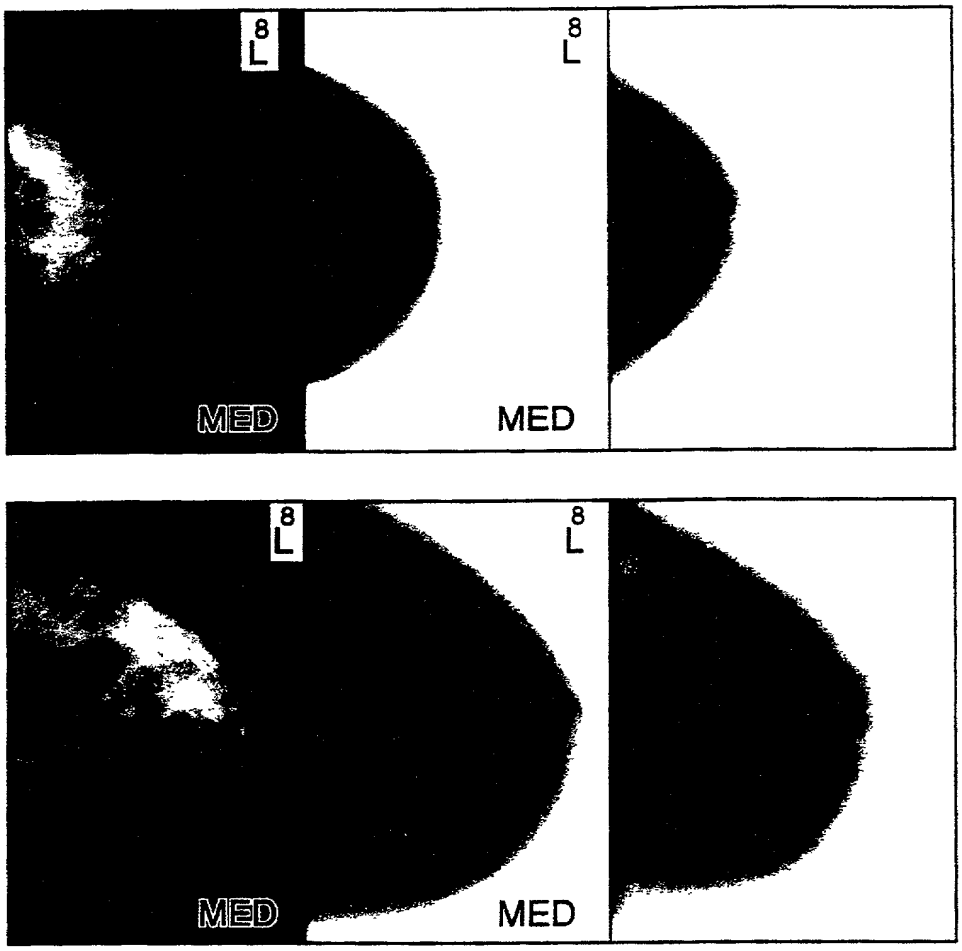


Fig.25.

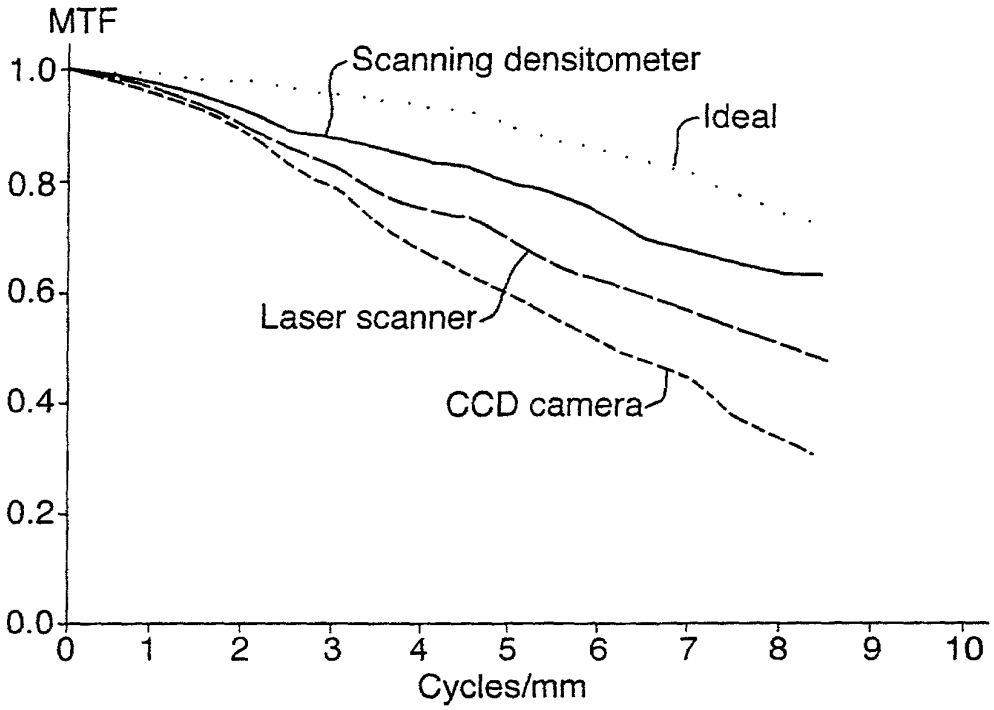

MTF
1.0
0.8
0.6
0.4
0.2
0.0
Scanning densitometer
Ideal
Laser scanner
CCD camera
0 1 2 3 4 5 6 7 8 9 10
Cycles/mm

Fig.26.

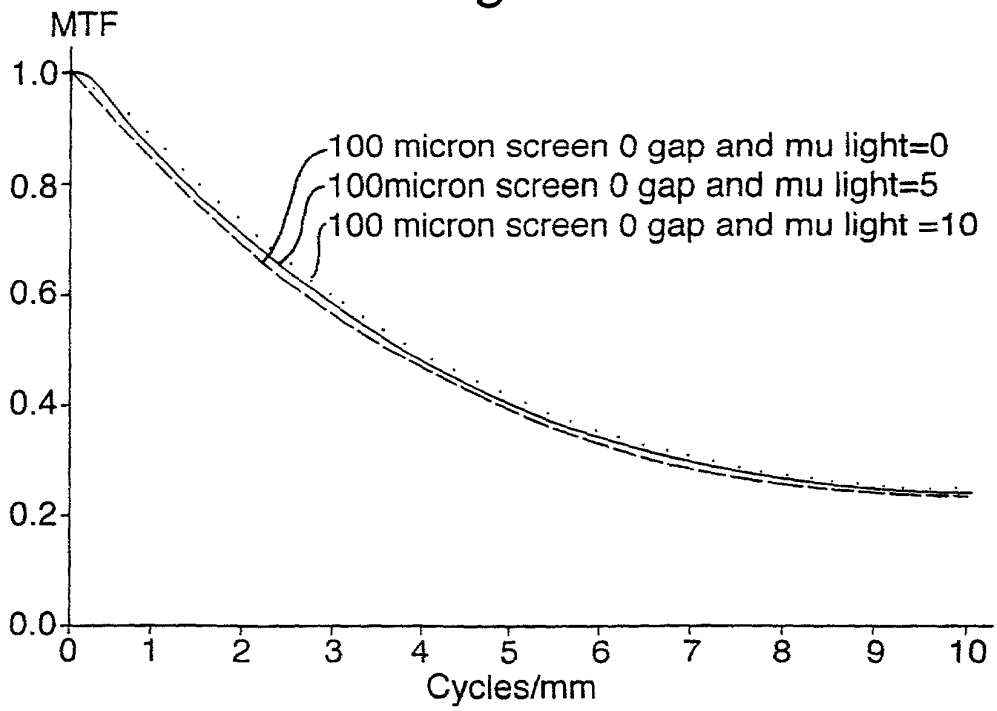

MTF
1.0
0.8
0.6
0.4
0.2
0.0
100 micron screen 0 gap and mu light=0
100micron screen 0 gap and mu light=5
100 micron screen 0 gap and mu light =10
0 1 2 3 4 5 6 7 8 9 10
Cycles/mm

Fig.27.

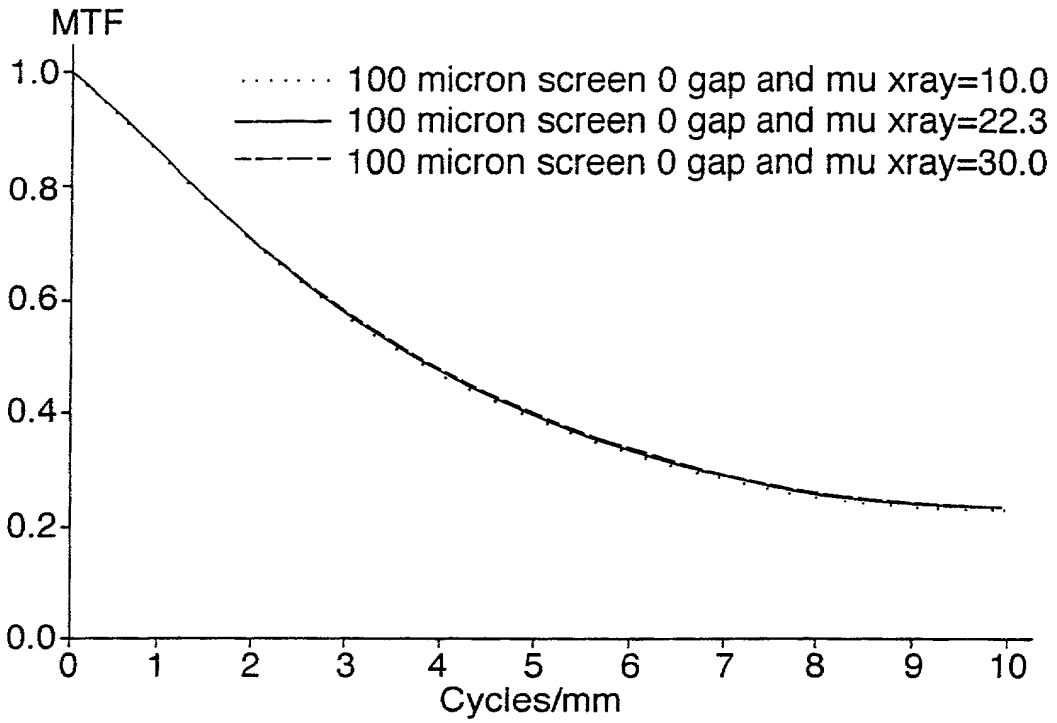

MTF
1.0
0.8
0.6
0.4
0.2
0.0
100 micron screen 0 gap and mu xray=10.0
100 micron screen 0 gap and mu xray=22.3
100 micron screen 0 gap and mu xray=30.0
0 1 2 3 4 5 6 7 8 9 10
Cycles/mm

Fig.28.

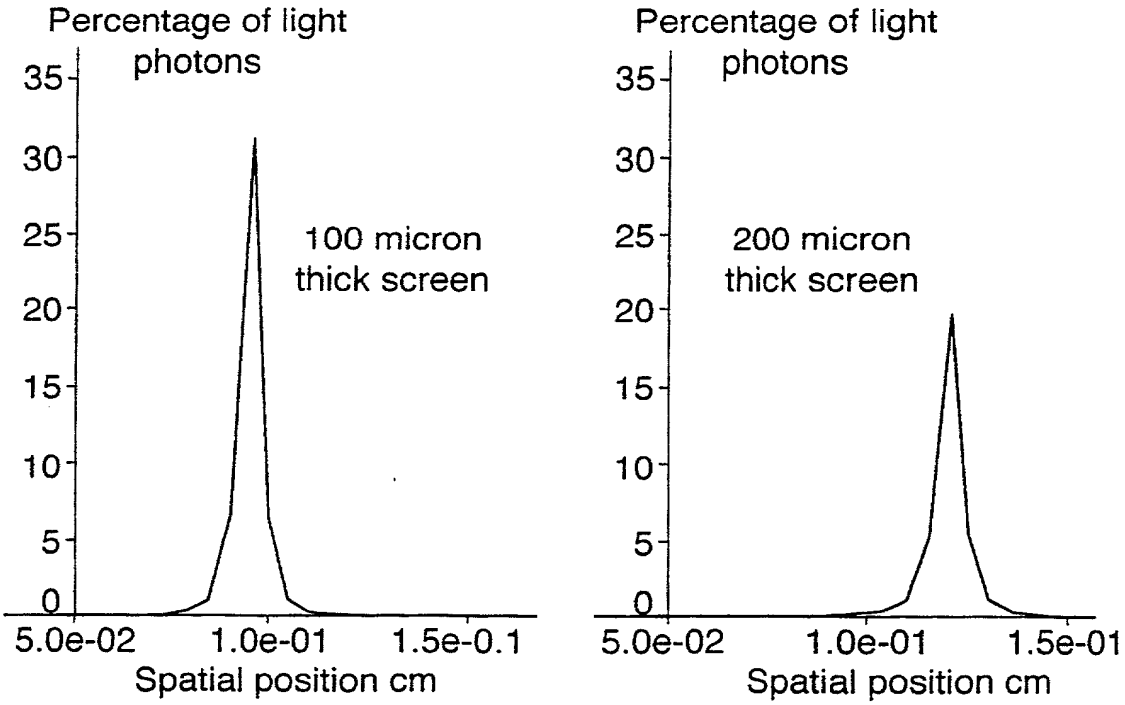

Percentage of light photons
35
30
25
20
15
10
5
0
100 micron thick screen
5.0e-02 1.0e-01 1.5e-0.1
Spatial position cm
Percentage of light photons
35
30
25
20
15
10
5
0
200 micron thick screen
5.0e-02 1.0e-01 1.5e-01
Spatial position cm

Fig.29.

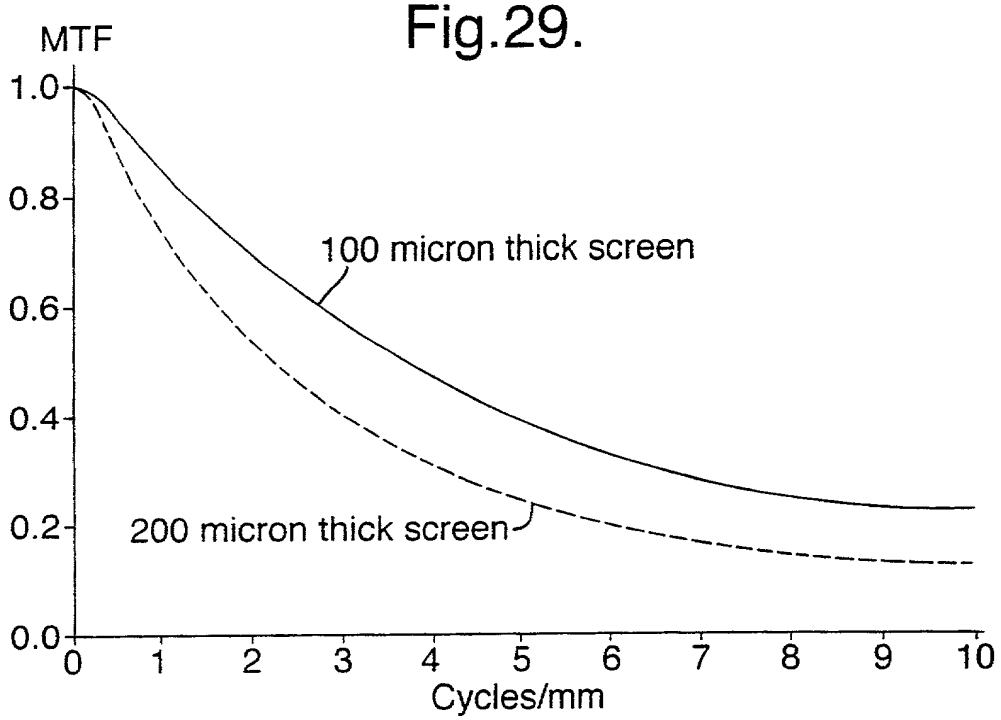

MTF
1.0
0.8
0.6
0.4
0.2
0.0
100 micron thick screen
200 micron thick screen
0 1 2 3 4 5 6 7 8 9 10
Cycles/mm

Fig.30.

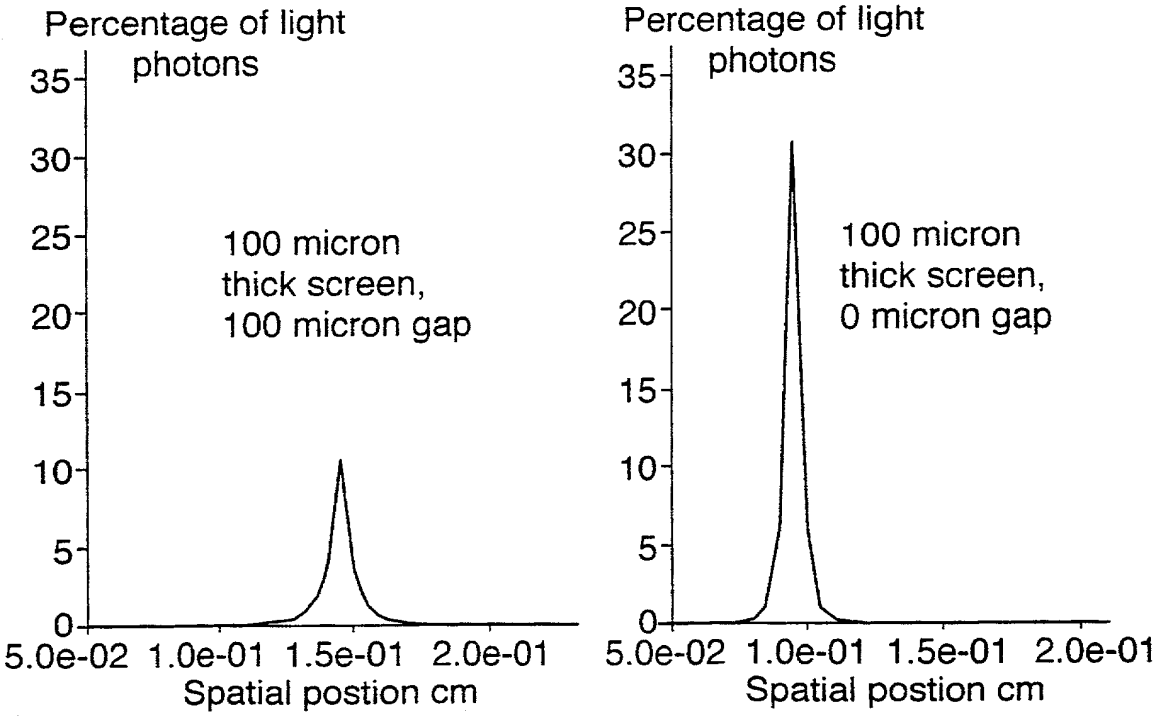

Percentage of light photons
35
30
25
20
15
10
5
0
100 micron thick screen, 100 micron gap
5.0e-02 1.0e-01 1.5e-01 2.0e-01
Spatial postion cm
Percentage of light photons
35
30
25
20
15
10
5
0
100 micron thick screen, 0 micron gap
5.0e-02 1.0e-01 1.5e-01 2.0e-01
Spatial postion cm

Fig.31.

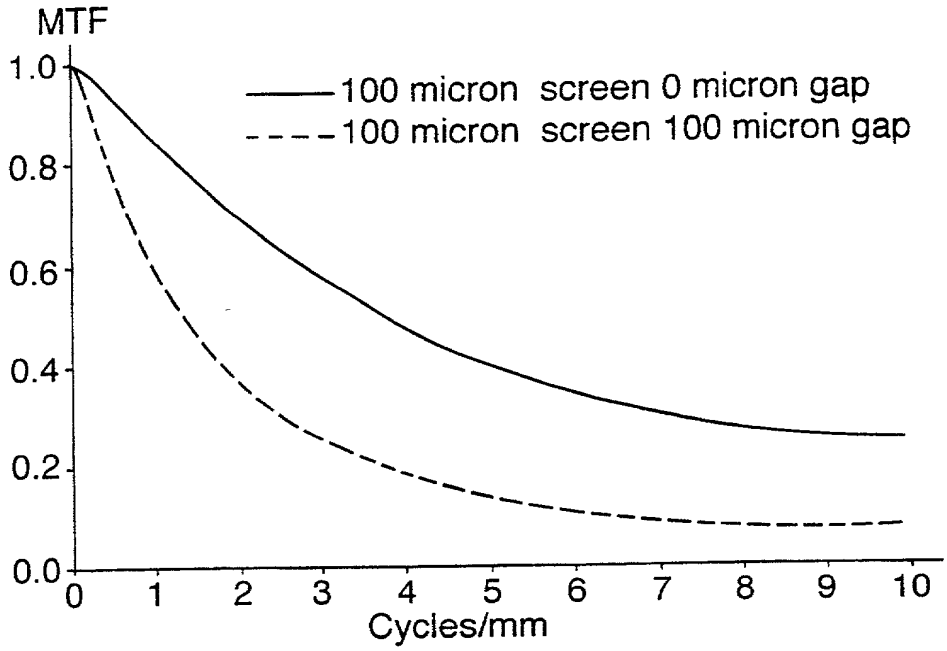
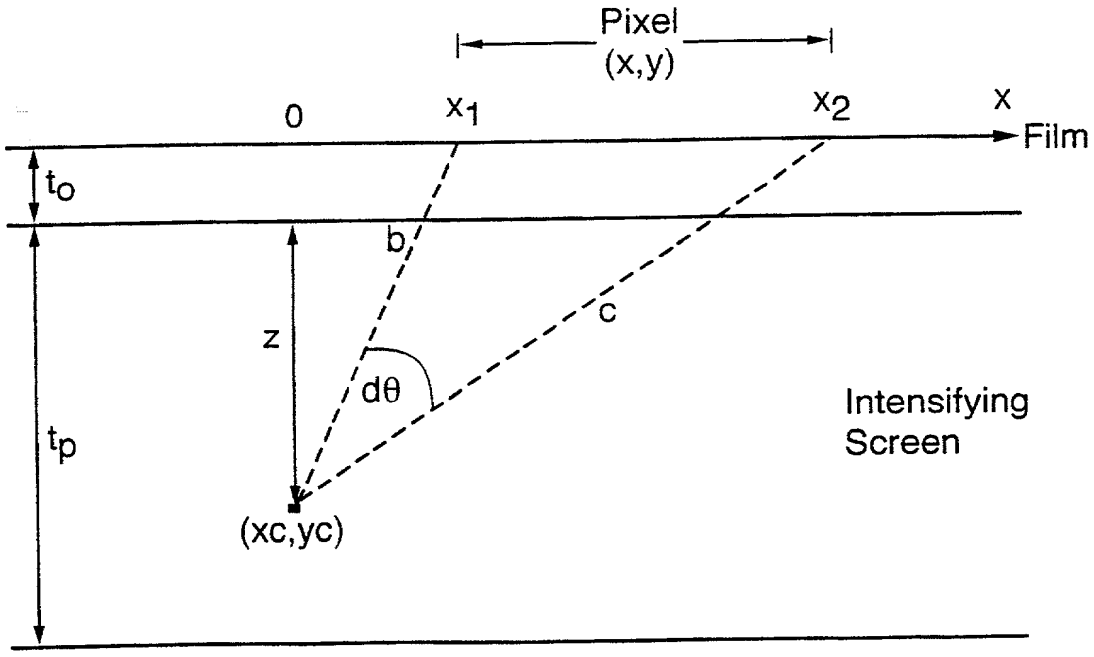

MTF
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10
Cycles/mm
100 micron screen 0 micron gap
100 micron screen 100 micron gap

Fig.32.


Pixel
(x,y)
0
x1
x2
x
Film
to
b
c
z
dθ
tp
Intensifying
Screen
(xc,yc)